CLAIMS

What is claimed is:

1. A semiconductor optical amplifier, comprising:

a signal waveguide including a signal guiding layer; and

a laser cavity including an active layer, said active layer being separate from said signal guiding layer;

wherein said active layer is positioned sufficiently near said signal guiding layer for an optical signal propagating along said signal guiding layer to be amplified by an evanescent coupling effect with said active layer.

2. The semiconductor optical amplifier of claim 1, wherein said signal guiding layer is a passive layer.

3. The semiconductor optical amplifier of claim 2, said signal waveguide comprising an input facet for receiving the optical signal and an output facet for outputting an amplified version of the optical signal, said input and output facets each being processed for antireflective transmission, said laser cavity further comprising two end facets, said end facets each having a reflectivity of not less than 10%, said end facets facilitating lasing action in said laser cavity when pumped with an excitation current greater than a threshold current.

4. The semiconductor optical amplifier of claim 3, said input and output facets being disposed at longitudinally opposing ends of the semiconductor optical amplifier, said signal waveguide guiding the optical signal along an optical signal path between said input and output facets, wherein said active layer of said laser cavity is separated from said signal guiding layer of said signal waveguide by not less than 0.1 μm and not more than 2.0 μm along a first interval of the optical signal path in which said optical amplification occurs.

5. The semiconductor optical amplifier of claim 4, wherein a lasing direction of said laser cavity is transverse to the optical signal path along said first interval thereof.

6. The semiconductor optical amplifier of claim 4, wherein a lasing direction of said laser cavity is substantially parallel to the optical signal path along said first interval thereof.

7. The semiconductor optical amplifier of claim 6, said laser cavity end facets also being disposed at said longitudinally opposing ends of the semiconductor optical amplifier, said laser cavity emitting unused laser light from said end facets when pumped with said excitation current greater than said threshold current, wherein said laser cavity is laterally separated from the optical signal path near said longitudinally opposing ends by an amount sufficient to inhibit introduction of the unused laser light into external devices to which the signal waveguide is coupled.

8. The semiconductor optical amplifier of claim 7, wherein said optical signal path extends in a substantially straight direction from the input facet to the output facet, and wherein said laser cavity follows a crooked path near its end facets to achieve said lateral separation from the optical signal path.

9. The semiconductor optical amplifier of claim 8, said active layer having a gain characteristic extending over a first wavelength range, said optical signal comprising wavelengths in a second wavelength range, and said laser cavity having a lasing wavelength in a third wavelength range, wherein said second wavelength range lies entirely within said first wavelength range, and wherein said third wavelength range is a subset of said first wavelength range that is non-overlapping with said second wavelength range.

10. The semiconductor optical amplifier of claim 9, wherein said active layer comprises an InGaAsP/InGaAs/InP material system, wherein said first wavelength range lies between 1510-1580 nm, wherein said second wavelength range lies between 1530-1570 nm, and wherein said third wavelength range lies between 1510-1520 nm.

11. A semiconductor optical amplifier formed from a vertical arrangement of substantially parallel material layers, the semiconductor optical amplifier amplifying an optical signal while confining it to an optical signal path substantially parallel to the material layers, the semiconductor optical amplifier comprising:

a signal waveguide including a signal guiding layer, said signal waveguide vertically confining the optical signal around said signal guiding layer, said signal waveguide extending from an input facet to an output facet and defining said optical signal path therebetween; and

a laser cavity including an active layer, said laser cavity being disposed between two end mirrors and defining a lasing path therebetween, said lasing path and said optical signal path vertically coinciding at an evanescent coupling region, said active layer and said signal guiding layer being vertically separated in said evanescent coupling region by at least one intervening layer;

wherein said vertical separation between said active layer and said signal guiding layer in said evanescent coupling region is sufficiently small for an optical signal propagating along said signal guiding layer to be amplified by an evanescent coupling effect with said active layer.

12. The semiconductor optical amplifier of claim 11, wherein gain-clamped amplification of the optical signal is achieved when lasing action is established in said laser cavity.

13. The semiconductor optical amplifier of claim 12, wherein said laser cavity is segmented along said lasing path into a plurality of electrically isolated segments including a main segment that includes said evanescent coupling region and at least one auxiliary segment that does not include said evanescent coupling region, and wherein said main segment and said auxiliary segment are supplied with separately adjustable bias currents.

14. The semiconductor optical amplifier of claim 13, said lasing action being achieved in said laser cavity when said main segment bias current exceeds a main

segment threshold, said optical signal experiencing gain-clamped amplification in said evanescent coupling region by a gain factor that does not vary substantially as the main segment bias current is further increased past said main segment threshold, said gain factor being positively and monotonically related to said main segment threshold.

15. The semiconductor optical amplifier of claim 14, said gain factor being dynamically adjustable through variation of said auxiliary segment bias current, said gain factor increasing as said auxiliary segment bias current is decreased, said gain factor decreasing as said auxiliary segment bias current is increased.

16. The semiconductor optical amplifier of claim 15, wherein adjacent laser cavity segments are separated by connecting strips structured to electrically isolate the adjacent laser cavities while being substantially optically transparent.

17. The semiconductor optical amplifier of claim 16, wherein said active layer and said signal guiding layer are proton-implanted within said connecting strips such that said adjacent laser cavities are electrically isolated.

18. The semiconductor optical amplifier of claim 17, wherein said active layer is disordered within said connecting strips such that said connecting strip is substantially optically transparent.

19. The semiconductor optical amplifier of claim 17, wherein said active layer is not disordered within said connecting strips, and wherein said connecting strips have a resistivity profile tailored to provide sufficient electrical isolation between the adjacent laser cavities while also allowing bias currents therefrom to bleed into the active layer to establish the optical transparency of the connecting strips.

20. The semiconductor optical amplifier of claim 18, wherein said active layer is disordered in regions vertically coinciding with said signal waveguide but lying outside the lasing path of the laser cavity.

21. A semiconductor optical amplifier, comprising:

a signal waveguide including a signal guiding layer, said signal waveguide defining an optical signal path between an input and an output; and

a laser cavity including an active layer, said laser cavity being disposed between two end mirrors and defining a lasing path therebetween, said lasing path and said optical signal path vertically coinciding at an evanescent coupling region, said active layer and said signal guiding layer being vertically separated in said evanescent coupling region by at least one intervening layer;

wherein said vertical separation between said active layer and said signal guiding layer in said evanescent coupling region is sufficiently small for an optical signal propagating along said signal guiding layer to be amplified by an evanescent coupling effect with said active layer;

and wherein said end mirrors each have a reflectivity of not less than 10%, said end mirrors facilitating lasing action in said laser cavity when pumped with an excitation current greater than a threshold current, said lasing action facilitating gain-clamped amplification of the optical signal.

22. The semiconductor optical amplifier of claim 21, wherein said vertical separation is not less than 0.1 μm and not more than 2.0 μm.

23. The semiconductor optical amplifier of claim 21, said lasing path being substantially parallel to said optical signal path in said evanescent coupling region.

24. The semiconductor optical amplifier of claim 23, said evanescent coupling region having a first end and a second end, said first end being nearer said input and said second end being nearer said output, said optical signal propagating along said signal waveguide from said first end to said second end of said evanescent coupling region, wherein said vertical separation between said active layer and said signal guiding layer varies from a first extremum near said first end to a second extremum near said second end, said optical signal being amplified by varying amounts as it propagates from said first end to said second end of said evanescent coupling region.

25. The semiconductor optical amplifier of claim 23, said input and outputs being respectively disposed at longitudinally opposing edges of the semiconductor optical amplifier, said end mirrors of said laser cavity also being respectively disposed at said longitudinally opposing edges, said end mirrors being separated from said input and output along said longitudinally opposing edges, said optical signal path being substantially straight between said input and output, said lasing path being curved near said longitudinally opposing edges to accommodate said separations.

26. The semiconductor optical amplifier of claim 23, said input and outputs being respectively disposed at longitudinally opposing edges of the semiconductor optical amplifier, said end mirrors of said laser cavity being disposed along other edges of said semiconductor optical amplifier not parallel to said longitudinally opposing edges, said lasing path following an S-like trajectory between said end mirrors.

27. The semiconductor optical amplifier of claim 21, said lasing path being transverse to said optical signal path in said evanescent coupling region.

28. The semiconductor optical amplifier of claim 21, wherein said laser cavity is segmented along said lasing path into a plurality of electrically isolated segments including a main segment that includes said evanescent coupling region and at least one auxiliary segment that does not include said evanescent coupling region, and wherein said main segment and said auxiliary segment are supplied with separately adjustable bias currents.

29. The semiconductor optical amplifier of claim 28, said lasing action being achieved in said laser cavity when said main segment bias current exceeds a main segment threshold, said optical signal experiencing gain-clamped amplification in said evanescent coupling region by a gain factor that does not vary substantially as the main segment bias current is further increased past said main segment threshold, said gain factor being positively and monotonically related to said main segment threshold.

30. The semiconductor optical amplifier of claim 29, said gain factor being dynamically adjustable through variation of said auxiliary segment bias current, said gain factor increasing as said auxiliary segment bias current is decreased, said gain factor decreasing as said auxiliary segment bias current is increased.

31. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers extending in a longitudinal direction from a first edge to a second edge thereof, the SOA vertically and horizontally confining an optical signal along an optical signal path between the first edge and the second edge, the SOA comprising:

an input facet disposed along said first edge;

an output facet disposed along said second edge;

a signal waveguide extending from said input facet to said output facet along said optical signal path, said signal waveguide comprising:

a signal guiding layer comprising a passive waveguiding material;

two cladding layers disposed vertically above and below said signal guiding layer, respectively, for vertically confining the optical signal around said signal guiding layer; and

a horizontal confinement structure for horizontally confining the optical signal along the optical signal path;

and

a laser cavity including an active layer vertically separated from the signal guiding layer by a first distance across at least one intervening layer, said first distance being small enough for an optical signal propagating along said signal guiding layer to be amplified by an evanescent coupling effect with said active layer of said laser cavity.

32. The SOA of claim 31, said laser cavity being disposed between two end mirrors and defining a lasing path therebetween, said lasing path and said optical signal path vertically coinciding at an evanescent coupling region, said active layer and said signal guiding layer being vertically separated by said first distance within said evanescent coupling region.

33. The SOA of claim 32, said first and second edges being substantially parallel, said lasing path being substantially parallel to said optical signal path in said evanescent coupling region, said end mirrors being positioned on third and fourth edges of the SOA substantially perpendicular to said first and second edges, said laser cavity following a curved path from one end mirror through the evanescent coupling region to the other end mirror.

34. The SOA of claim 33, wherein said laser cavity comprises a periodic grating structure for discouraging extraneous modes therein, said periodic grating structure lying outside said evanescent coupling region.

35. The SOA of claim 32, said first and second edges being substantially parallel, said lasing path being substantially perpendicular to said optical signal path in said evanescent coupling region, said end mirrors being positioned on third and fourth edges of the SOA substantially perpendicular to said first and second edges, said laser cavity following a substantially straight path from one end mirror through the evanescent coupling region to the other end mirror.

36. The SOA of claim 35, wherein said laser cavity is tapered to have a first width near one of said end mirrors that is narrower than a second width within said evanescent coupling region, the laser cavity having reduced electrical current requirements as compared to a similar but non-tapered laser cavity configuration.

37. The SOA of claim 35, wherein said laser cavity comprises a periodic grating structure for discouraging extraneous modes therein, said periodic grating structure extending into said evanescent coupling region.

38. The SOA of claim 32, wherein said laser cavity comprises a periodic grating structure for discouraging extraneous modes therein.

39. The SOA of claim 31, wherein said horizontal confinement structure comprises a longitudinally extending ridge element positioned on an opposite side of one of said cladding layers with respect to said signal guiding layer, said ridge element providing lateral confinement by an effective refractive index guiding effect.

40. The SOA of claim 39, wherein horizontal confinement for said laser cavity is provided by a rib element formed at an interface between two differently-indexed layers vertically positioned near said active layer, said rib element providing lateral confinement by an effective refractive index guiding effect.

41. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

an input facet for receiving the optical signal;

an output facet for outputting an amplified version of the optical signal;

a signal waveguide including a signal guiding layer, the signal waveguide extending in a first direction between said input facet and said output facet and defining the optical signal path therebetween; and

a transverse laser cavity oriented in a second direction transverse to said first direction, said transverse laser cavity and said signal waveguide defining a signal amplification region at locations of vertical coincidence therebetween, said transverse laser cavity being integrated with said signal waveguide into the vertical arrangement of substantially parallel material layers such that said optical signal is amplified in said signal amplification region using energy provided by said transverse laser cavity;

wherein said transverse laser cavity comprises a periodic grating structure for inhibiting generation of extraneous lasing modes in the transverse laser cavity.

42. The SOA of claim 41, said signal guiding layer comprising a passive waveguiding material, said transverse laser cavity including an active layer vertically separated from said signal guiding layer in said signal amplification region by at least one intervening layer, said vertical separation being sufficiently small such that the optical signal

propagating along said signal guiding layer is amplified in said signal amplification region by an evanescent coupling effect with said active layer.

43. The SOA of claim 41, said signal guiding layer comprising a gain medium, said transverse laser cavity including an active layer coextensive with said gain medium of said signal guiding layer in said regions of amplification, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said signal gain medium by said transverse laser cavity.

44. The SOA of claim 41, wherein said periodic grating structure comprises distributed Bragg reflector (DBR) gratings.

45. The SOA of claim 44, wherein said DBR gratings are formed in said transverse laser cavity at locations other than said signal amplification region.

46. The SOA of claim 41, wherein said periodic grating structure comprises distributed feedback (DFB) gratings.

47. The SOA of claim 46, said second direction being substantially perpendicular to said first direction, wherein said DFB gratings at least partially extend into said signal amplification region.

48. The SOA of claim 41, said input and output facets of said SOA having been treated for antireflective transmission, said laser cavity further comprising two end mirrors each having a reflectivity of at least 10%.

49. The SOA of claim 41, said gain medium lying within said signal amplification region having a gain characteristic extending over a first wavelength range, said optical signal comprising wavelengths in a second wavelength range, and said laser cavity having a lasing wavelength in a third wavelength range, wherein said second wavelength range lies entirely within said first wavelength range, and wherein said third wavelength

range is a subset of said first wavelength range that is non-overlapping with said second wavelength range.

50. The semiconductor optical amplifier of claim 49, wherein said gain medium lying within said signal amplification region comprises an InGaAsP/InGaAs/InP material system, wherein said first wavelength range lies between 1510-1580 nm, wherein said second wavelength range lies between 1530-1570 nm, and wherein said third wavelength range lies between 1510-1520 nm.

51. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

an input facet for receiving the optical signal;

an output facet for outputting an amplified version of the optical signal;

a signal waveguide including a signal guiding layer, the signal waveguide extending in a first direction between said input facet and said output facet and defining the optical signal path therebetween; and

a transverse laser cavity oriented in a second direction transverse to said first direction, said transverse laser cavity and said signal waveguide defining a signal amplification region at locations of vertical coincidence therebetween, said transverse laser cavity being integrated with said signal waveguide into the vertical arrangement of substantially parallel material layers such that said optical signal is amplified in said signal amplification region using energy provided by said transverse laser cavity;

wherein said transverse laser cavity is segmented into a plurality of electrically isolated segments including a main segment that includes said signal amplification region and at least one auxiliary segment that does not include said signal amplification region, and wherein said main segment and said auxiliary segment are supplied with separately adjustable bias currents.

52. The SOA of claim 51, said signal guiding layer comprising a passive waveguiding material, said transverse laser cavity including an active layer vertically separated from

said signal guiding layer in said signal amplification region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said signal amplification region by an evanescent coupling effect with said active layer.

53. The SOA of claim 51, said signal guiding layer comprising a gain medium, said transverse laser cavity including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said transverse laser cavity.

54. The SOA of claim 51, wherein lasing action is achieved in said transverse laser cavity when said main segment bias current exceeds a main segment threshold, the optical signal experiencing gain-clamped amplification in said signal amplification region when said lasing action is achieved.

55. The SOA of claim 54, wherein the gain-clamped amplification of said optical signal is by a gain factor that does not vary substantially as said main segment bias current is further increased past said main segment threshold, said gain factor being positively and monotonically related to said main segment threshold.

56. The SOA of claim 55, said gain factor being dynamically adjustable through variation of said auxiliary segment bias current, said gain factor increasing as said auxiliary segment bias current is decreased, said gain factor decreasing as said auxiliary segment bias current is increased.

57. The SOA of claim 51, wherein said transverse laser cavity comprises a periodic grating structure for discouraging extraneous modes therein

58. The SOA of claim 51, said transverse laser cavity having a nominal lasing wavelength, said optical signal having a nominal signal wavelength, said transverse laser

cavity comprising an active layer extending through each of said main segment and said auxiliary segment and having identical material properties in both, wherein said active layer has a first gain vs. wavelength characteristic that peaks near said nominal lasing wavelength when operating at a first junction temperature, and wherein said active layer has a second gain vs. wavelength characteristic that peaks near said nominal signal wavelength when operating at a second junction temperature different than said first junction temperature.

59. The SOA of claim 58, wherein said active layer in said auxiliary segment operates at said first junction temperature and said active layer in said main segment operates at said second junction temperature when said auxiliary segment and said main segment are provided with first and second bias currents, respectively.

60. The SOA of claim 51, said transverse laser cavity having a nominal lasing wavelength, said optical signal having a nominal signal wavelength, said main segment comprising a first active layer, said auxiliary segment comprising a second active layer having different material characteristics than said first active layer, wherein said first active layer has a first gain vs. wavelength characteristic that peaks near said nominal signal wavelength, and wherein said second active layer has a second gain vs. wavelength characteristic that peaks near said nominal lasing wavelength.

61. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

an input facet for receiving the optical signal;

an output facet for outputting an amplified version of the optical signal;

a signal waveguide including a signal guiding layer, the signal waveguide extending in a first direction between said input facet and said output facet and defining the optical signal path therebetween; and

a coupled-cavity laser pair including a first laser cavity and a second laser cavity positioned along a common lasing axis transverse to said first direction, said first laser

cavity and said signal waveguide defining a signal amplification region at locations of vertical coincidence therebetween, said second laser cavity not vertically coinciding with said signal waveguide, said first laser cavity being integrated with said signal waveguide into the vertical arrangement of substantially parallel material layers such that said optical signal is amplified in said signal amplification region using energy provided by said first laser cavity.

62. The SOA of claim 61, said signal guiding layer comprising a passive waveguiding material, said first laser cavity including an active layer vertically separated from said signal guiding layer in said signal amplification region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said signal amplification region by an evanescent coupling effect with said active layer.

63. The SOA of claim 61, said signal guiding layer comprising a gain medium, said first laser cavity including an active layer coextensive with said gain medium of said signal guiding layer in said regions of amplification, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said signal gain medium by said first laser cavity.

64. The SOA of claim 61, said first laser cavity having a first length consistent with a first longitudinal mode set, said second laser cavity having a second length consistent with a second longitudinal mode set, said first laser cavity operating at a lasing wavelength that is a member of each of said first and second longitudinal mode sets.

65. The SOA of claim 64, wherein said first and second lengths are close but not identical to each other, said first laser cavity operating in a strongly monochromatic manner at said lasing wavelength due a large wavelength interval between said lasing wavelength and the nearest alternative permitted longitudinal mode for the coupled-cavity laser pair.

66. The SOA of claim 61, said first and second laser cavities having a gap formed therebetween by a cleaving process.

67. The SOA of claim 61, said first and second laser cavities having a gap formed therebetween by an etching process.

68. The SOA of claim 61, wherein said first laser cavity is segmented along said common lasing axis into a plurality of electrically isolated segments including a main segment that includes said signal amplification region and at least one auxiliary segment that does not include said signal amplification region, and wherein said main segment and said auxiliary segment are supplied with separately adjustable bias currents.

69. The SOA of claim 68, wherein lasing action is achieved in said first laser cavity when said main segment bias current exceeds a main segment threshold, the optical signal experiencing gain-clamped amplification in said signal amplification region when said lasing action is achieved, said gain-clamped amplification being by a gain factor that does not vary substantially as the main segment bias current is further increased past said main segment threshold.

70. The SOA of claim 69, said gain factor being dynamically adjustable through variation of said auxiliary segment bias current, said gain factor increasing as said auxiliary segment bias current is decreased, said gain factor decreasing as said auxiliary segment bias current is increased.

71. A semiconductor optical amplifier, comprising:

a signal waveguide including a signal guiding layer, said signal waveguide defining an optical signal path between an input and an output; and

a plurality of laser cavities, each laser cavity including an active layer, each laser cavity being disposed between two end mirrors and defining a lasing path therebetween, said lasing paths being non-overlapping with each other, each lasing path vertically coinciding with said optical signal path at a distinct evanescent coupling region within

which said active layer and said signal guiding layer are vertically separated by at least one intervening layer;

wherein, for each of said plurality of laser cavities, said vertical separation between said active layer and said signal guiding layer in said evanescent coupling region is sufficiently small for an optical signal propagating along said signal guiding layer to be amplified by an evanescent coupling effect with said active layer.

72. The semiconductor optical amplifier of claim 71, said semiconductor optical amplifier being formed from a vertical arrangement of substantially parallel material layers into which said signal waveguide and said plurality of laser cavities are integrated, said optical signal path longitudinally extending from a first edge to a second edge of said semiconductor optical amplifier, wherein said lasing path of each laser cavity is transverse to said optical signal path in its associated evanescent coupling region.

73. The semiconductor optical amplifier of claim 72, wherein said end mirrors of said laser cavities are disposed along said first and second edges, respectively, each lasing path following an S-like trajectory between said end mirrors.

74. The semiconductor optical amplifier of claim 72, wherein said end mirrors of said laser cavities are disposed along third and fourth edges of said semiconductor optical amplifier substantially perpendicular to said first and second edges, respectively, each lasing path following a straight-line trajectory between said end mirrors.

75. The semiconductor optical amplifier of claim 71, said semiconductor optical amplifier being formed from a vertical arrangement of substantially parallel material layers into which said signal waveguide and said plurality of laser cavities are integrated, said optical signal path longitudinally extending from a first edge to a second edge of said semiconductor optical amplifier, wherein said lasing path of each laser cavity is substantially parallel to said optical signal path in its associated evanescent coupling region.

76. The semiconductor optical amplifier of claim 75, wherein said end mirrors of said laser cavities are disposed along third and fourth edges of said semiconductor optical amplifier substantially perpendicular to said first and second edges, respectively, each lasing path following an S-like trajectory between said end mirrors.

77. The semiconductor optical amplifier of claim 75, wherein said end mirrors of said laser cavities are disposed along said first and second edges, respectively, each lasing path following an S-like trajectory between said end mirrors.

78. The semiconductor optical amplifier of claim 71, wherein said plurality of laser cavities are electrically isolated from each other and are supplied with separate bias currents, and wherein gain-clamped amplification of the optical signal is achieved in the evanescent coupling region of each laser cavity when lasing action is achieved therein.

79. The semiconductor optical amplifier of claim 78, wherein for each of said laser cavities said lasing action is achieved when said bias current exceeds a lasing threshold current, said gain-clamped amplification of said optical signal being by a gain factor that does not vary substantially as said bias current is further increased past said lasing threshold current.

80. The semiconductor optical amplifier of claim 79, said optical signal path longitudinally extending from a first edge to a second edge of said semiconductor optical amplifier, each of said bias currents resulting in a bias current density within its respective laser cavity, each of said laser cavities achieving said lasing action when provided with a bias current density greater than a lasing threshold current density corresponding to said lasing threshold current, said gain factor increasing with increased lasing threshold current density, said gain factor increasing with increased amplification distance, said amplification distance corresponding to a longitudinal extent of said evanescent coupling region along said optical signal path.

81. The semiconductor optical amplifier of claim 80, said plurality of laser cavities having identical lateral dimensions and identical gain factors.

82. The semiconductor optical amplifier of claim 80, said plurality of laser cavities having different gain factors by virtue of differences thereamong in one or more items selected from the group consisting of: amplification distance, end mirror reflectivity, and gain medium composition.

83. The semiconductor optical amplifier of claim 71, said plurality of laser cavities being electrically isolated from each other, each laser cavity being segmented into a plurality of electrically isolated segments including a main segment that includes said evanescent coupling region and at least one auxiliary segment that does not include said evanescent coupling region, said main segment and said auxiliary segment being supplied with separately adjustable bias currents, said bias currents also being separately adjustable across said plurality of laser cavities.

84. The semiconductor optical amplifier of claim 83, wherein for each laser cavity, for a fixed auxiliary segment bias current, lasing action is achieved when said main segment bias current exceeds a main segment threshold, said optical signal experiencing gain-clamped amplification in said evanescent coupling region by a gain factor that does not vary substantially as the main segment bias current is further increased past said main segment threshold, said gain factor being positively and monotonically related to said main segment threshold.

85. The semiconductor optical amplifier of claim 84, said gain factor being dynamically adjustable in each of said laser cavities through variation of said auxiliary segment bias current, said gain factor increasing as said auxiliary segment bias current is decreased, said gain factor decreasing as said auxiliary segment bias current is increased.

86. The semiconductor optical amplifier of claim 71, each of said plurality of laser cavities having a different lasing wavelength.

87. The semiconductor optical amplifier of claim 71, said semiconductor optical amplifier containing N laser cavities sequentially disposed along said optical signal path, wherein all even numbered laser cavities have an operating wavelength λ_1 and all odd numbered laser cavities have a different operating wavelength λ_2.

88. The semiconductor optical amplifier of claim 71, said semiconductor optical amplifier comprising N such laser cavities sequentially disposed along said optical signal path, said N laser cavities operating at M different wavelengths $\lambda_1, \ldots, \lambda_M$, $2 \leq M \leq N$, wherein the i^{th} laser cavity has an operating wavelength of $\lambda_{(i \bmod M)}$.

89. The semiconductor optical amplifier of claim 88, wherein each of said N laser cavities comprises a periodic grating structure consistent with its respective operating wavelength.

90. The semiconductor optical amplifier of claim 89, each of said N laser cavities having a lasing path substantially perpendicular to said optical signal path in said evanescent coupling regions, wherein said periodic grating structure are distributed feedback (DFB) gratings that extend into said evanescent coupling regions.

91. A method of making a semiconductor optical amplifier having a signal waveguide including a signal guiding layer and a plurality of transverse laser cavities including an active layer, the signal guiding layer being non-coplanar with the active layer in regions of vertical intersection therebetween, an optical signal propagating along the signal guiding layer being amplified by an evanescent coupling effect with the active layer when passing through the regions of vertical intersection, said method comprising:

forming an active layer at locations including the transverse laser cavities;

forming an intervening layer laterally encompassing at least said regions of vertical intersection;

forming a signal guiding layer at locations including said signal waveguide, said signal guiding layer being formed on a side of said intervening layer opposite said active

layer, wherein said intervening layer has a thickness at said regions of intersection consistent with said evanescent coupling effect between said active layer and said signal guiding layer; and

performing an electrically isolating implant across areas of the semiconductor optical amplifier other than the transverse laser cavities.

92. The method of claim 91, wherein said electrically isolating implant penetrates said active layer for facilitating electrical isolation between active layers of the successive transverse laser cavities.

93. The method of claim 92, said intervening layer comprising a first cladding layer having a refractive index lower than each of said active layer and said signal guiding layer, said method further comprising forming a signal cladding layer on a side of said signal guiding layer opposite said first cladding layer, said signal cladding layer having a refractive index lower than said signal guiding layer.

94. The method of claim 93, further comprising etching away said signal cladding layer at locations other than said signal waveguide to form a ridge guiding element for the signal waveguide, said ridge guiding element providing lateral confinement for the optical signal.

95. The method of claim 94, further comprising:

forming a laser waveguiding layer on a side of said active layer opposite said first cladding layer, said laser waveguiding layer having a refractive index similar to that of said active layer; and

forming a laser cladding layer on a side of said laser waveguiding layer opposite said active layer, said laser cladding layer having a refractive index less than said active layer.

96. The method of claim 95, further comprising, prior to forming said laser waveguiding layer, etching said laser cladding layer at locations along said transverse

laser cavities, wherein said laser waveguiding element when formed protrudes into said laser cladding layer to form a rib element for each transverse laser cavity that provides lateral confinement of a lasing field of that cavity.

97. The method of claim 96, further comprising disordering said active layer in areas lying outside of said transverse laser cavities that vertically coincide with said signal waveguide.

98. The method of claim 97, further comprising disordering said active layer in all areas of said semiconductor optical amplifier lying outside said transverse laser cavities.

99. The method of claim 98, further comprising forming a metallization layer at locations corresponding to said transverse laser cavities.

100. The method of claim 99, further comprising forming end mirrors on each transverse laser cavity by (i) etching their end facets using a reactive ion etching process, and (ii) depositing a reflective material at each end facet such that each end mirror has a reflectivity of not less than 10 percent.

101. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

an input facet for receiving the optical signal;

an output facet for outputting an amplified version of the optical signal;

a signal waveguide including a signal guiding layer, the signal waveguide extending between said input facet and said output facet and defining the optical signal path therebetween; and

a plurality of transverse laser cavities, each transverse laser cavity being disposed between two end mirrors and defining a lasing path therebetween, each transverse laser cavity being electrically isolated from the others, said lasing paths being non-overlapping with each other, each lasing path vertically coinciding with said optical signal path at a

distinct signal amplification region, each of said transverse laser cavities being integrated with said signal waveguide into the vertical arrangement of substantially parallel material layers such that said optical signal is amplified in each signal amplification region using energy provided by each respective transverse laser cavity;

wherein each transverse laser cavity is segmented into a plurality of electrically isolated segments including a main segment that includes said signal amplification region and at least one auxiliary segment that does not include said signal amplification region, wherein said main segment and said auxiliary segment are supplied with separately adjustable bias currents.

102. The SOA of claim 101, said signal guiding layer comprising a passive waveguiding material, each of said transverse laser cavities including an active layer vertically separated from said signal guiding layer in its respective signal amplification region by at least one intervening layer, said vertical separation being sufficiently small such that the optical signal propagating along said signal guiding layer is amplified in said signal amplification region by an evanescent coupling effect with said active layer.

103. The SOA of claim 101, said signal guiding layer comprising a gain medium, each of said transverse laser cavities including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said transverse laser cavity.

104. The SOA of claim 101, a first of said transverse laser cavities having its signal amplification region closer to said input facet, a second of said transverse laser cavities having its signal amplification region closer to said output facet, the active layers of said first and second transverse lasers comprising substantially similar materials, each of said separately adjustable bias currents resulting in a bias current density within its respective transverse laser cavity segment, wherein lasing action is achieved in each transverse laser cavity when its main segment bias current density exceeds a main segment current

density threshold, the optical signal experiencing gain-clamped amplification in the associated signal amplification region when said lasing action is achieved.

105. The SOA of claim 104, wherein the gain-clamped amplification of said optical signal is by a gain factor that does not vary substantially as said main segment bias current density is further increased past said main segment current density threshold, said gain factor being positively and monotonically related to said main segment current density threshold.

106. The SOA of claim 105, said main segment current density threshold and said gain factor being dynamically adjustable through variation of said auxiliary segment bias current density, said main segment current density threshold and said gain factor each increasing as said auxiliary segment bias current density is decreased, said main segment current density threshold and said gain factor each decreasing as said auxiliary segment bias current density is increased.

107. The SOA of claim 106, wherein a signal-to-noise ratio in said amplified version of said optical signal is dynamically adjustable through dynamic adjustments of said main and auxiliary segment bias current densities in said first and second transverse laser cavities while an overall optical signal gain stays the same.

108. The SOA of claim 107, said first transverse laser cavity having a quiescent main segment bias current density of $J1_M$(old) and a quiescent auxiliary segment bias current density of $J1_A$(old) yielding a quiescent signal gain of g1(old) in its signal amplification region, said second transverse laser cavity having a quiescent main segment bias current density of $J2_M$(old) and a quiescent auxiliary segment bias current density of $J2_A$(old) yielding a quiescent signal gain of g2(old) in its signal amplification region, wherein said active layers of said first and second transverse lasers possess a sublinear relationship between percent spontaneous emission noise change and percent signal gain change such that when quiescent operation points are changed to $J1_A(new) < J1_A(old)$,

$J1_M(new) > J1_M(old)$, $g1(new) > g1(old)$, $J2_A(new) > J2_A(old)$, $J2_M(new) < J2_M(old)$, $g2(new) < g2(old)$, with $g1(new)g2(new) = g1(old)g2(old)$, the amount of amplified spontaneous emission noise in said amplified version of said optical signal is reduced.

109. The SOA of claim 107, said first transverse laser cavity having a quiescent main segment bias current density of $J1_M(old)$ and a quiescent auxiliary segment bias current density of $J1_A(old)$ yielding a quiescent signal gain of $g1(old)$ in its signal amplification region, said second transverse laser cavity having a quiescent main segment bias current density of $J2_M(old)$ and a quiescent auxiliary segment bias current density of $J2_A(old)$ yielding a quiescent signal gain of $g2(old)$ in its signal amplification region, wherein said active layers of said first and second transverse lasers possess a superlinear relationship between percent spontaneous emission noise change and percent signal gain change such that when quiescent operation points are changed to $J1_A(new) > J1_A(old)$, $J1_M(new) < J1_M(old)$, $g1(new) < g1(old)$, $J2_A(new) < J2_A(old)$, $J2_M(new) > J2_M(old)$, $g2(new) > g2(old)$, with $g1(new)g2(new) = g1(old)g2(old)$, the amount of amplified spontaneous emission noise in said amplified version of said optical signal is reduced.

110. The SOA of claim 101, wherein the lasing path of each of said transverse laser cavities is substantially parallel to the optical signal path in its respective signal amplification region.

111. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

an input facet for receiving the optical signal;

an output facet for outputting an amplified version of the optical signal;

a signal waveguide including a signal guiding layer, the signal waveguide extending between said input facet and said output facet and defining the optical signal path therebetween; and

a plurality of substantially identical transverse laser cavities, each transverse laser cavity being disposed between two end mirrors and defining a lasing path therebetween,

each transverse laser cavity being electrically isolated from the others, said lasing paths being non-overlapping with each other, each lasing path vertically coinciding with said optical signal path at a distinct signal amplification region, each of said transverse laser cavities being integrated with said signal waveguide into the vertical arrangement of substantially parallel material layers such that said optical signal is amplified in each signal amplification region using energy provided by each respective transverse laser cavity;

wherein each transverse laser cavity is segmented into a plurality of electrically isolated segments including a main segment that includes said signal amplification region and at least one auxiliary segment that does not include said signal amplification region, wherein said main segment and said auxiliary segment are supplied with separate bias currents.

112. The SOA of claim 111, wherein for each transverse laser cavity, for a fixed auxiliary segment bias current, lasing action is achieved when said main segment bias current exceeds a main segment threshold, said optical signal experiencing gain-clamped amplification in said signal amplification region by a gain factor that does not vary substantially as the main segment bias current is further increased past said main segment threshold, said gain factor being positively and monotonically related to said main segment threshold.

113. The SOA of claim 112, a first of said transverse laser cavities having its signal amplification region closer to said input facet, a second of said transverse laser cavities having its signal amplification region closer to said output facet, each of said transverse laser cavities including an active layer having a sublinear relationship between percent spontaneous emission noise change and percent signal gain change, wherein said auxiliary segment of said first transverse laser cavity has a bias current that is less than that of the auxiliary segment of said second laser cavity, and wherein said main segment of said first transverse laser cavity has a bias current that is greater than that of the main segment of said second laser cavity.

114. The SOA of claim 113, said signal guiding layer comprising a passive waveguiding material, each of said transverse laser cavities including an active layer vertically separated from said signal guiding layer in its respective signal amplification region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said signal amplification region by an evanescent coupling effect with said active layer.

115. The SOA of claim 113, said signal guiding layer comprising a gain medium, each of said transverse laser cavities including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said transverse laser cavity.

116. The SOA of claim 112, a first of said transverse laser cavities having its signal amplification region closer to said input facet, a second of said transverse laser cavities having its signal amplification region closer to said output facet, each of said transverse laser cavities including an active layer having a superlinear relationship between percent spontaneous emission noise change and percent signal gain change, wherein said auxiliary segment of said first transverse laser cavity has a bias current that is greater than that of the auxiliary segment of said second laser cavity, and wherein said main segment of said first transverse laser cavity has a bias current that is less than that of the main segment of said second laser cavity.

117. The SOA of claim 116, said signal guiding layer comprising a passive waveguiding material, each of said transverse laser cavities including an active layer vertically separated from said signal guiding layer in its respective signal amplification region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said signal amplification region by an evanescent coupling effect with said active layer.

118. The SOA of claim 116, said signal guiding layer comprising a gain medium, each of said transverse laser cavities including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said transverse laser cavity.

119. The SOA of claim 111, wherein the lasing path of each of said transverse laser cavities is substantially parallel to the optical signal path in its respective signal amplification region.

120. The SOA of claim 111, wherein the lasing path of each of said transverse laser cavities is substantially perpendicular to the optical signal path in its respective signal amplification region.

121. A semiconductor optical amplifier (SOA) formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

an input facet for receiving the optical signal;

an output facet for outputting an amplified version of the optical signal;

a signal waveguide including a signal guiding layer, the signal waveguide extending between said input facet and said output facet and defining the optical signal path therebetween; and

a plurality of transverse laser cavities, each transverse laser cavity being disposed between two end mirrors and defining a lasing path therebetween, said lasing paths being non-overlapping with each other, each lasing path vertically coinciding with said optical signal path at a distinct signal amplification region, each of said transverse laser cavities being integrated with said signal waveguide into the vertical arrangement of substantially parallel material layers such that said optical signal is amplified in each signal amplification region using energy provided by each respective transverse laser cavity;

wherein at least two of said plurality of transverse laser cavities have different operating wavelengths.

122. The SOA of claim 121, each of said transverse laser cavities having a different lasing wavelength.

123. The SOA of claim 121, said SOA containing N transverse laser cavities sequentially disposed along said optical signal path, wherein all even numbered transverse laser cavities have an operating wavelength λ_1 and all odd numbered transverse laser cavities have a different operating wavelength λ_2.

124. The SOA of claim 121, said SOA comprising N such transverse laser cavities sequentially disposed along said optical signal path, said N transverse laser cavities operating at M different wavelengths $\lambda_1, \ldots, \lambda_M$, $2 \leq M \leq N$, wherein the i^{th} transverse laser cavity has an operating wavelength of $\lambda_{(i \bmod M)}$.

125. The SOA of claim 124, wherein each of said N transverse laser cavities comprises a periodic grating structure consistent with its respective operating wavelength.

126. The SOA of claim 125, each of said N transverse laser cavities having a lasing path substantially perpendicular to said optical signal path in said signal amplification regions, wherein said periodic grating structures are distributed feedback (DFB) gratings that extend into said signal amplification regions.

127. The SOA of claim 126, said signal guiding layer comprising a passive waveguiding material, each of said transverse laser cavities including an active layer vertically separated from said signal guiding layer in its respective signal amplification region by at least one intervening layer, said vertical separation being sufficiently small such that the optical signal propagating along said signal guiding layer is amplified in said signal amplification region by an evanescent coupling effect with said active layer.

128. The SOA of claim 126, said signal guiding layer comprising a gain medium, each of said transverse laser cavities including an active layer coextensive with said gain

medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said transverse laser cavity.

129. The SOA of claim 125, wherein said periodic grating structures are distributed Bragg reflector (DBR) gratings.

130. The SOA of claim 121, said transverse laser cavities being electrically isolated from each other and being supplied with separate bias currents, lasing action being achieved in each transverse laser cavity when its bias current exceeds a threshold, the optical signal experiencing gain-clamped amplification in the associated signal amplification region when said lasing action is achieved, said transverse laser cavities including a first plurality of transverse laser cavities interleaved with a second plurality of transverse laser cavities with respect to said optical signal path, said first plurality of transverse laser cavities being biased above threshold for gain-clamped amplification, said second plurality of transverse laser cavities being biased below threshold and experiencing nonlinear gain saturation effects for achieving a nonlinear signal processing operation on the optical signal.

131. An integrated semiconductor optical amplifier (SOA) array formed from a vertical arrangement of substantially parallel material layers, the SOA guiding an optical signal along an optical signal path while amplifying the optical signal therealong, the SOA comprising:

a plurality of signal waveguides, each signal waveguide extending between an input facet and an output facet and defining an optical signal path therebetween; and

a plurality of ballast lasers, each ballast laser being disposed between two end mirrors and defining a lasing path therebetween, each lasing path vertically coinciding with each of said optical signal paths at a distinct signal amplification region, each of said ballast lasers being integrated with said plurality of signal waveguides into the vertical arrangement of substantially parallel material layers such that said optical signals are

amplified in each signal amplification region using energy provided by each respective ballast laser.

132. The SOA array of claim 131, each signal waveguide including a signal guiding layer, said signal guiding layers comprising passive waveguiding materials, each of said ballast lasers including an active layer vertically separated from said signal guiding layer in its respective signal amplification region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said signal amplification region by an evanescent coupling effect with said active layer.

133. The SOA of claim 131, each signal waveguide including a signal guiding layer, said signal guiding layer comprising a gain medium, each of said ballast lasers including an active layer coextensive with said gain media of said signal guiding layers in said signal amplification regions, said optical signals being amplified in said signal amplification regions by operation of a population inversion established in said gain media by said ballast lasers.

134. The SOA array of claim 131, wherein at least two of said ballast lasers have different operating wavelengths

135. The SOA array of claim 131, wherein said signal waveguides do not intersect each other.

136. The SOA array of claim 131, wherein said ballast lasers do not intersect each other.

137. The SOA array of claim 131, further comprising a separately adjustable attenuation region for each signal waveguide comprising an adjustably lossy optical material, each optical signal experiencing a similar cumulative gain "G" from the ballast

lasers, each optical signal having an adjustable overall gain equal to "G" minus its individually adjustable attenuation.

138. The SOA array of claim 131, wherein said ballast lasers are substantially identical to each other.

139. The SOA array of claim 131, wherein said ballast lasers each comprise multiple electrically isolated segments that receive separate bias currents, the gain for each ballast laser being separately and dynamically adjustable through separate and dynamic manipulation of said bias currents.

140. The SOA array of claim 131, wherein the lasing path of each ballast lasers is substantially perpendicular the optical signal path of each signal waveguide in said signal amplification regions.

141. An optical integrated circuit for receiving a wavelength division multiplexed (WDM) optical signal having channels at $\lambda_1\lambda_2\ldots\lambda_N$ and generating a resultant signal therefrom, comprising:

a substrate;

a semiconductor optical amplifier (SOA) formed on said substrate, said SOA comprising:

a first signal waveguide including a signal guiding layer; and

a ballast laser cavity, the ballast laser cavity and the first signal waveguide being positioned within the optical integrated circuit such that the optical signal is amplified using energy provided by the ballast laser cavity as it propagates along said signal guiding layer of said first signal waveguide;

and

a tunable coupler formed adjacent to said SOA on said substrate, said tunable coupler having at least one material layer in common with said SOA, said tunable coupler comprising:

a second signal waveguide receiving the optical signal from the SOA; and

a third signal waveguide tunably coupled with the second signal waveguide such that optical signals at $\lambda_1\lambda_2\ldots\lambda_N$ are transferred over to the third signal waveguide, the resultant signal being derived from an output of said third signal waveguide;

wherein a substantial portion of amplified spontaneous emission (ASE) noise remains in said second signal waveguide and does not couple efficiently into said third signal waveguide, said resultant signal being an amplified version of the WDM optical signal in an ASE-reduced form.

142. The optical integrated circuit of claim 141, said signal guiding layer of said first signal waveguide comprising a passive waveguiding material, said ballast laser vertically coinciding with said first signal waveguide at an evanescent coupling region, said ballast laser including an active layer vertically separated from said signal guiding layer in said evanescent coupling region by at least one intervening layer, said vertical separation being sufficiently small such that the optical signal propagating along said signal guiding layer is amplified in said evanescent coupling region by an evanescent coupling effect with said active layer.

143. The optical integrated circuit of claim 142, wherein said signal guiding layer and a core layer of said second signal waveguide are laterally coincident and constitute the same layer of material in said optical integrated circuit.

144. The optical integrated circuit of claim 143, wherein said tunable coupler is a vertical coupler.

145. The optical integrated circuit of claim 141, said signal guiding layer comprising a gain medium, said ballast laser cavity including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical

signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said ballast laser cavity.

146. The optical integrated circuit of claim 145, wherein said signal guiding layer and a core layer of said second signal waveguide are laterally coincident and constitute the same layer of material in said optical integrated circuit, said core layer of said second signal waveguide being disordered to facilitate optical propagation therethrough.

147. The optical integrated circuit of claim 146, wherein said tunable coupler is a vertical coupler.

148. An optical integrated circuit for receiving a wavelength division multiplexed (WDM) optical signal having channels at $\lambda_1\lambda_2\ldots\lambda_N$ and generating (i) an electrical signal corresponding to the optical channel at λ_1, and (ii) a resultant optical signal therefrom, comprising:

a substrate;

a semiconductor optical amplifier (SOA) formed on said substrate, said SOA comprising:

a first signal waveguide including a signal guiding layer; and

a ballast laser cavity, the ballast laser cavity and the first signal waveguide being positioned within the optical integrated circuit such that the optical signal is amplified using energy provided by the ballast laser cavity as it propagates along said signal guiding layer of said first signal waveguide;

a tunable coupler formed adjacent to said SOA on said substrate, said tunable coupler having at least one material layer in common with said SOA, said tunable coupler comprising:

a second signal waveguide receiving the optical signal from the SOA; and

a third signal waveguide tunably coupled with the second signal waveguide such that optical signals at $\lambda_1\lambda_2\ldots\lambda_N$ are transferred over to the third signal waveguide;

and

a photodetector coupled to receive the optical channel at λ_1 from the third signal waveguide, said photodetector comprising a photoabsorptive material that generates the electrical signal corresponding to the optical channel at λ_1, the resultant optical signal being derived from an output of said third signal waveguide after the optical channel at λ_1 has been removed;

wherein a substantial portion of amplified spontaneous emission (ASE) noise remains in said second signal waveguide and does not couple efficiently into said third signal waveguide, said resultant optical signal being an amplified version of the WDM optical signal having channels $\lambda_2\ldots\lambda_N$ in an ASE-reduced form.

149. The optical integrated circuit of claim 148, said signal guiding layer of said first signal waveguide comprising a passive waveguiding material, said ballast laser vertically coinciding with said first signal waveguide at an evanescent coupling region, said ballast laser including an active layer vertically separated from said signal guiding layer in said evanescent coupling region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said evanescent coupling region by an evanescent coupling effect with said active layer.

150. The optical integrated circuit of claim 149, wherein said signal guiding layer and a core layer of said second signal waveguide are laterally coincident and constitute the same layer of material in said optical integrated circuit.

151. The optical integrated circuit of claim 150, wherein said tunable coupler is a vertical coupler.

152. The optical integrated circuit of claim 148, said signal guiding layer comprising a gain medium, said ballast laser cavity including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said gain medium by said ballast laser cavity.

153. The optical integrated circuit of claim 152, wherein said signal guiding layer and a core layer of said second signal waveguide are laterally coincident and constitute the same layer of material in said optical integrated circuit, said core layer of said second signal waveguide being disordered to facilitate optical propagation therethrough.

154. The optical integrated circuit of claim 153, wherein said tunable coupler is a vertical coupler.

155. A monolithic optical integrated circuit providing both optical return-to-zero (RZ) modulation and optical amplification, comprising:

a substrate;

a signal waveguide formed on said substrate including a signal guiding layer, an upper cladding layer thereabove, and a lower cladding layer therebelow, the signal waveguide extending from an input facet to an output facet, the signal waveguide guiding an optical signal therebetween, the optical signal being received in unmodulated carrier form at the input facet, the optical signal being provided in a modulated RZ format at the output facet;

a first electroabsorptive (EA) modulator formed on said substrate and positioned along said signal waveguide near said input facet, said first EA modulator amplitude-modulating the optical signal at a desired modulation rate with a desired duty cycle, said first EA modulator comprising an electroabsorptive core layer coextensive with said signal guiding layer;

a second EA modulator formed on said substrate and positioned along said signal waveguide after said first EA modulator, said second EA encoding the optical signal with

a desired bit pattern, said second EA modulator also comprising an electroabsorptive core layer coextensive with said signal guiding layer; and

a semiconductor optical amplifier (SOA) formed on said substrate and positioned along said signal waveguide after said second EA modulator, said signal guiding layer within said SOA having different material properties than within said first and second EA modulators, said SOA further comprising a ballast laser cavity, the ballast laser cavity being positioned with respect to said signal waveguide such that the optical signal is amplified using energy provided by the ballast laser cavity as it propagates along said signal guiding layer of said signal waveguide.

156. The optical integrated circuit of claim 155, said signal guiding layer within said SOA comprising a passive waveguiding material, said ballast laser vertically coinciding with said signal waveguide at an evanescent coupling region, said ballast laser including an active layer vertically separated from said signal guiding layer in said evanescent coupling region by at least one intervening layer, said vertical separation being sufficiently small for an optical signal propagating along said signal guiding layer to be amplified in said evanescent coupling region by an evanescent coupling effect with said active layer.

157. The optical integrated circuit of claim 156, wherein said upper cladding layer above said signal guiding layer is laterally coincident throughout said first EA modulator, said second EA modulator, and said SOA.

158. The optical integrated circuit of claim 155, said signal guiding layer within said SOA comprising a gain medium, said ballast laser vertically coinciding with said signal waveguide at a signal amplification region, said ballast laser cavity including an active layer coextensive with said gain medium of said signal guiding layer in said signal amplification region, said optical signal being amplified in said signal amplification region by operation of a population inversion established in said signal gain medium by said ballast laser cavity.

159. The optical integrated circuit of claim 158, wherein said upper cladding layer above said signal guiding layer is laterally coincident throughout said first EA modulator, said second EA modulator, and said SOA.

160. The optical integrated circuit of claim 155, further comprising a phase modulator formed on said substrate and positioned along said signal waveguide between said second EA modulator and said SOA, said phase modulating element comprising a phase modulating layer coextensive with said signal guiding layer.